IV. Findings on the Value of CRADAs

Generalized Findings

Many interesting findings were deduced from the information gathered from the interviews with the federal and non-federal CRADA partners on their particular collaborations. There is a belief that CRADAs should lead to commercial products in order to be considered "successful." However, in actuality this appears to be the exception rather than the rule. CRADAs typically entail knowledge-share opportunities that facilitate advances in research that lead to product or process improvements, advancing research to points that would have taken longer to achieve independently, or allowing an opportunity to perform research that would not have otherwise occurred due to restricted funding resources.

The following findings were recurring themes described by participants in the collaborations. Each finding is exemplified by one CRADA from each Service as well as an accompanying table illustrating additional CRADAs from the study that support the finding. Detailed descriptive information can be found in the referenced CRADA summaries (Appendices A, B, and C).

- *Many Labs see CRADAs as "mission extenders" permitting joint government-commercial funding of important research areas where limited resources do not permit full government funding*

  CRADA partnerships can help both the civilian and Military Agencies better meet technological needs by exploiting commercial technologies and markets to meet the Government's needs.[27] The use of the CRADA mechanism to support the laboratory mission was a recurring theme in this study. Statements heard throughout the interviewing process such as "CRADAs can leverage R&D dollars for both the federal and non-federal partner," "CRADA reimbursements have resulted in revenue for the laboratories," "royalty payments can lead to revenue for a laboratory and its scientists," and "the CRADA mechanism is the only technology transfer instrument where industry can input money, but DoD does not" are indicative of the intention of using the CRADA mechanism as a mission extender. Estimates of the leveraged R&D efforts for each of the CRADAs evaluated in this study can be found in the following section, Specific Findings.

For example, the CRADA between Walter Reed Army Institute of Research and the Medical Technology and Practice Patterns Institute, Inc., (MTPPI), provided a means for ideas that would have otherwise been held captive in financially strapped laboratories to flourish in the commercial sector where there is interest and scientists available and ready to apply the technology. The transdermal vaccine delivery system currently being developed under this CRADA is a needle-free delivery system. Many vaccine manufacturers as well as the Navy and Institutes of Health have expressed interest in this needle-free vaccine delivery system for effective, safe, and easily administered delivery mechanism for vaccination. MTPPI inputs approximately $250K annually in funding for conducting the human trials of their vaccines at WRAIR. MTPPI also inputs approximately $500K in associated personnel costs. (A8)

The objective of an ongoing CRADA between the Naval Air Warfare Center Weapons Division (NAWCWPNS) China Lake and Thiokol Corporation is to develop and demonstrate the performance of high quality explosive fill for warheads with the ultimate goal of testing a warhead containing CL-20 based explosive that demonstrates performance significantly above that of existing explosives. Thiokol has the capability to produce the quantities required for weapon demonstration. China Lake will build and test the weapons to demonstrate their capabilities. (N3)

In an agreement with the U.S. Air Force Research Laboratory, Human Effectiveness Directorate (AFRL/HE), and Northrop Corporation the partners planned, designed, conducted, analyzed, documented, and reported on concept demonstrations of advanced Air Force direct attack conventional target acquisition and weapon delivery avionics systems. The Air Force received

and integrated into their simulator facilities, improved/enhanced aircraft flight and conventional weapon delivery and weapon flyout models that were not available through in-house R&D project funds. In this leveraged R&D effort, the Air Force received $300K in reimbursement costs from Northrop. (AF6)

OTHER EXAMPLES

Number	CRADA Name	Remarks
A4	CORE-LOC Concrete Armor Unit	• Revenue from royalties and reimbursable studies is helping to leverage R&D funding • Annual royalties could exceed $1M from international sales
A10	Vaccines for Infectious Diseases	• Ora Vax has input approximately $300K/year for overhead and equipment associated with the development of vaccines • Ora Vax has four employees working on site at WRAIR
N6	Exploring the Effects of Lipid-Lowering Agents on Complex Cognitive and Performance Tests	• $300K was input for labor and materials associated with effort to study the side effects of two cholesterol-lowering medications on cognitive performance
N8	Ocean Bottom Profiler Joint Program	• R&D dollars were leveraged to meet objectives in the development of the Ocean Bottom Profiler
AF1	Automated Software for Composite Material Analysis	• A software package was developed consisting of solution procedures for the efficient analysis of composite materials • The Air Force has received $2K to date in royalties from the sale of the software to industry
AF2	Covert Adjustable Laser Illumination	• An integrated system of a fiber coupled diode laser to illuminate an image from a gimbaled assembly was derived from the core competencies of both partners
AF3	Hazardous Materials Management System	• The LINDEN™ hazardous materials tracking software was developed under a contract and Beta tested under the CRADA at the Air Force Research Laboratory • The commercialization of this product has generated $4K in royalties for the Air Force
AF8	USAF CRADA Between Weber State University and the Science and Engineering Laboratory	• Faculty and staff of Weber State University are provided access to Air Force laboratory equipment as well as to expertise • Cost for analyses performed at the Air Force laboratory are reimbursed

• *A CRADA can provide a means for industry to talk openly with government; proprietary information and intellectual property issues are handled in the CRADA negotiation. The ORTA can be instrumental in these negotiations.*

> Concerned over issues related to intellectual property, in the past industry has been reluctant to partner with the Federal laboratories. The CRADA mechanism provides a means of protecting company secrets by addressing intellectual property concerns up front in the negotiation process and writing them into the document itself.

For example, intellectual property and proprietary issues were major concerns of Goodyear Tire and Rubber and Caterpillar, Inc when they wanted to enter into a working partnership with the U.S. Army Cold Regions Research and Engineering Laboratory. The CRADA vehicle addressed these concerns in the negotiated agreement. Although the CRADA took longer to negotiate than had been originally anticipated, it was vital in bringing about this three party working relationship. (A3)

Although the technical POCs were eager to work together, initially Thiokol was reluctant to enter in the working relationship with the U.S. Naval Air Warfare Center, China Lake to manufacture the CL-20 explosive ingredient due to intellectual property issues. As a result of a secrecy order on the China Lake patented process for making CL-20, Thiokol had developed and patented a process of their own which entailed a slight modification to one of the original steps. When the

secrecy order was lifted, Thiokol wanted to license the China Lake process. NAWC licensed the technology to Thiokol for a minimal fee. (N3)

OTHER EXAMPLES

Number	CRADA Name	Remarks
A7	Evaluation of Electron Cyclotron Resonance Plasma Technology	• The industry partner felt more comfortable establishing a CRADA before sharing knowledge with the government
N6	Exploring the Effects of Lipid-Lowering Agents on Complex Cognitive and Performance Tests	• Industry partner greatly appreciated the detailed efforts taken by the ORTA in negotiating the agreement • The carefully negotiated CRADA was instrumental in solving an issue that arose at the end of the CRADA over ownership of the generated data

• *CRADAs are a means of advancing research to points that would have taken longer to achieve independently. Even when the objectives set forth in the CRADA aren't met, less money and time is spent going down the wrong path.*

In times of constrained R&D budgets, whether it be a small business, a large business or a DoD laboratory, everyone can benefit from leveraging expertise that lies outside of their own labs. Drawing upon external expertise can provide the means to overcome obstacles that can present themselves along the path to new discoveries or even determine that the path being pursued is leading to a dead-end and another needs to be followed.

After only one year, Texas Instruments and U.S. Army Communications and Electronics Research, Development and Engineering Center, Night Vision and Electronic Sensors Directorate were successful in achieving milestones toward the development of a plasma etching manufacturing process for the development of next generation focal plane arrays. According to the participants interviewed, had each partner pursued this work individually, progress to this point would have taken several years. (A7)

The objective of an initial CRADA between the Naval Research Laboratory and Quantum Magnetics was to look at using quadrupole resonance to detect heroin hydrochloride and cocaine hydrochloride, but the signal proved very difficult to see. It was determined that the objectives of the initial CRADA were too aggressive. Therefore, a second CRADA was negotiated to focus on specific advanced circuitry to detect narcotics and explosives. It was noted that this collaboration provided a faster way to explore solutions thereby saving time and R&D dollars. (N4)

Similarly, a partnership between Northrop Corporation and the Air Force Research Laboratory Human Effectiveness Directorate, allowed actual warfighters to use and provide feedback on Northrop's target acquisition and weapon avionics system. This early feedback was used to modify and improve the design early in the development cycle, saving Northrop and the Air Force time and money. (AF6)

ANOTHER EXAMPLE

Number	CRADA Name	Remarks
N1	CRADA Between the Naval Training Systems Center and the Computer Group of Motorola, Inc.	• Had there not been a CRADA mechanism, both partners would have pursued the same work individually, taking longer to obtain similar results

• *CRADAs can provide access to government/military facilities that are not otherwise commercially available resulting in first hand experience with future capabilities as well as reimbursements to the Federal labs.*

There are a limited number of test sites available to industry for the testing of new systems. Unique facilities exist that are important for DoD to maintain, but are not fully utilized on a daily basis. CRADAs can be used to arrange for the use of a particular test site or laboratory facility that is not otherwise commercially available (without competing with commercial labs or facilities). Allowing industry access to unique

facilities can offset the cost in maintaining critical internal expertise in military relevant technologies.

A CRADA between Walter Reed Army Institute of Research and Ora Vax, Inc. allows Ora Vax employees to utilize WRAIR facilities for their vaccine production. The WRAIR controlled laboratories are unique facilities that are required for the production of vaccine for Phase I and Phase II clinical trials. In times of shrinking budgets, the funds input to WRAIR by Ora Vax (approximately $250K) provide resources and revenue to support the laboratory and increase the usage of the facility. (A10)

In a CRADA between Hughes Missile Systems and the Air Force Development Test Center at Eglin AFB, Hughes used an Air Force arena test facility to test a warhead design. Hughes reduced their financial risk by not having to build their own test facility and Eglin AFB benefited by having $58K in direct support costs reimbursed. (AF9)

ANOTHER EXAMPLE

Number	CRADA Name	Remarks
AF5	Ogden Air Logistics Center X-Ray/Computed Topography Sections	• ARACOR needed access to demonstration sites for testing and qualifying new hardware and software being developed to enhance the Computed Topography machine's capabilities • ARACOR partner reimbursed the Air Force $75K for associated direct support costs

• *A CRADA can result in new, improved, or more cost effective products and processes sometimes leading to the development of a commercial supplier/resource to DoD.*

Although some feel that technology transfer is the process of identifying and transferring commercially viable technologies to the private sector, CRADAs typically entail small advances in research leading to product or process improvements. However, sometimes CRADAs do lead to new, commercializable products which provide the DoD with more affordable procurements that meet their technological needs. A table showing the products and product improvements resulting from the CRADAs evaluated in this study can be found in the following section, Specific Findings.

The Navy was using a fluorinated polyurethane paint as the top coat for their Navy Facilities Engineering Command, Navy Facilities Guide Specification 09872, four-coat paint system for coating the inside of petroleum storage tanks. This top coat cost $750.00 per gallon. 21st Century Inc. licensed the technology for the fluorinated polyurethane from the Naval Research Laboratory and combined it with technology from other patents and developed a three-coat variant paint system called WC5, Navy Facilities Guide Specification 09970.

21st Century tested this new paint system at the Naval Research Laboratory paint shop facility. The top coat on the WC5 paint system is a highly fluorinated coating that is very stable, flexible, chip resistant, UV resistant, and hydrophobic. As an example of the cost savings, a tank that is 40 feet in diameter by 35 feet in height coated with the old system would cost approximately $29,714.00 compared to the same tank coated with the WC5 system costing approximately $12,952.00. The savings just in the application costs in going from a four-coat process to a three-coat process is $2,827.44. WC5 is now used on Navy petroleum storage tanks as well as those of the Army Corps of Engineers. (N7)

Under a CRADA, Adtech Systems Research and the Air Force Research Laboratory, Materials and Manufacturing Directorate, were able to develop a fully documented commercial software package, Automated Software for Composite Analysis (ASCA). This software package consists of solution procedures for the efficient analysis of composite materials that are leading to new and innovative avenues for developing optimum designs and establishing new goals. (AF1)

OTHER EXAMPLES

Number	CRADA Name	Remarks
A5	Development of Biodegradable Polymers	• A paper cup coated with a biodegradable plastic was developed and is sold under the name of "Biopol"
N1	CRADA Between the Naval Training System Center and the Computer Group of Motorola, Inc.	• Efforts in working with the DIS interoperability standard resulted in three software products/tools that provide the interface between simulators
N3	Demonstration of CL-20 Based Explosive Formulations	• Thiokol scaled-up their manufacturing capability of the CL-20 explosive ingredient becoming the only producer of CL-20 and currently the only commercial source of the ingredient • Thiokol has been marketing the basic ingredient as well as end-product formulations for use in explosives and gun propellants
N8	Ocean Bottom Profiler Joint Project	• Acoustic transducers, receiver arrays, and acoustic baffles were incorporated into the vehicle design that have made the profiler vehicle superior in performance to all bottom profiling vehicles worldwide
AF3	Hazardous Materials Management system	• A software package to computerize and track hazardous materials was Beta tested at the Air Force Laboratory and subsequently commercialized
AF4	Helmet Mounted Display (HMD) Fitness of Use	• KOPIN was provided access to an actual military maintenance environment for the evaluation of their HMDs for use as a maintenance tool • The Air Force was able to provide valuable feedback to KOPIN on the use of the HMD resulting in a commercialized product

- *CRADAs can eliminate interpersonal barriers that can arise in a contractual relationship.*

  Often times the success of a CRADA is the result of enthusiastic S&E's working together towards a common goal. To reduce bureaucratic burden as much as possible and streamline the approval process, each Service and even some individual laboratories within each Service have developed a model or standard CRADA.

The industry partner in the CRADA with the U.S. Naval Air Warfare Center, China Lake and Thiokol attributed the success of the CRADA to the true partnership relationship that is involved in contrast to the contractor/government relationship that typically exists with a contract. The partners are working together to develop and demonstrate the performance of high quality explosive fill for warheads whose performance is significantly above that of existing explosives. Thiokol has the capability to make the quantities required for weapon demonstration. China Lake will build and test the weapons to demonstrate their capabilities. (N3)

In a CRADA between the Air Force Research Laboratory, Human Effectiveness Directorate, and KOPIN Corporation, a Fitness of Use study was undertaken to examine the effectiveness of Helmet Mounted Displays (HMD) in mobile computing applications. This working relationship allowed the government and industry to work together as equal partners rather than in a typical contractor arrangement. KOPIN appreciated the opportunity to share information with the Air Force technicians who used their display. (AF4)

ANOTHER EXAMPLE

Number	CRADA Name	Remarks
N1	CRADA Between the Naval Training System Center and the Computer group of Motorola, Inc.	• The partners had a good working relationship; they had previously worked together under a contract as well as on trade shows in the area of interoperability for the networking of simulators
N8	Ocean Bottom Profiler Joint Project	• The federal and non-federal partners had known each other for over 30 years and were very enthusiastic about working with each other

- *CRADAs are successful when clear objectives are laid out.*

  As with any well run research program, a CRADA with clearly defined objectives and milestones provides a clear path for meeting research goals. Having a clearly laid out path to follow allows individuals to easily come and go during the course of the project.

The CRADA between Communications Electronics Command, Night Vision and Electronic Sensors Directorate and Silicon Graphics, Inc. could have been more successful if objectives had been laid out. After initially progressing, retirements and resignations by both partners occurred. Not having objectives laid out made it difficult for replacements to track what was supposed to be achieved. (A1)

In contrast, objectives and milestones were clearly laid out in a successful CRADA between Bristol-Myers Squibb and the U.S. Naval Aerospace Medical Research Laboratory to study the effects of two cholesterol-lowering medications on cognitive performance. The industry partner clearly defined the protocol which was incorporated into the written statement-of-work and thus attributed to the objectives being met. (N6)

ANOTHER EXAMPLE

Number	CRADA Name	Remarks
N8	Ocean Bottom Profiler Joint Project	• Objectives and responsibilities were clearly laid out • Both partners agreed that "a CRADA shouldn't have too many objectives, but rather a few clearly defined ones"

- *CRADAs can advance knowledge for both partners sometimes leading to new programs/contracts.*

  As was also found in a 1994 GAO report,[28] Federal laboratories and private companies collaborating on research can advance R&D programs. New knowledge can lead to advancing the research to the next level in the development cycle or can spawn new ideas leading to new R&D programs altogether.

The working partnership between the U.S. Army Research Laboratory (ARL) and the Composites Development Corporation allowed ARL to further its research in pultrusion manufacturing techniques which can produce stronger, lighter, and more durable materials more quickly and at lower costs. Each party learned a considerable amount about how tougher, hybridized resins can be processed successfully at low viscosities with pultrusion, as well as improved methods of "feeding" glass and carbon fiber into pultrusion die "on-the-fly." (A9)

In the CRADA between the Naval Surface Warfare Center, Crane Division and AdvanceTek, an Indiana not-for-profit organization, a partnership was formed with the two CRADA partners and Purdue University and Indiana University to advance basic research in methods of measuring the usable energy capacity in batteries. The research conducted under this CRADA will provide AdvanceTek with a basic understanding of battery technology which will promote long-term developments in the electric vehicle and hybrid electric vehicle technologies. This new knowledge may also lead to the effective use of batteries as a propulsion mechanism which is of interest to both the automobile and electric power generation industries. (N5)

In the CRADA between the U.S. Air Force Development Test Center at Eglin AFB and Hughes Missile Systems, knowledge was gained in the fragmentation pattern of a new warhead designed

by Hughes Missile Systems. This knowledge led to future contracts for Hughes in this technology area. (AF9)

OTHER EXAMPLES

Number	CRADA Name	Remarks
A6	Development of Novel Imaging System for Medical, Non-Destructive Testing & Investigation of Micro-electronic Circuits	• Knowledge gained in this CRADA led to the development of an array as part of an Small Business Innovative Research, SBIR, contract with the Air Force for use in non-destructive measurement of fatigue in airplane wings
A7	Evaluation of Electron Cyclotron Resonance Plasma Technology	• Advancements toward the development of next generation focal plane arrays was achieved • Knowledge was advanced in using plasma technology for cleaning wafer surfaces which has led to a new concept for forming microlenses • Scientists at Night Vision and Electronic Sensors Directorate have published four technical papers in the technology area of plasma etching technology
N2	Deep-Towed Acoustic/ Geophysical System	• Data on geophysical properties of seafloor sediments was gathered that otherwise would not have been attained
N3	Demonstration of CL-20 Based Explosive Formulations	• A FY99 Navy ManTech program is planned to scale up the CL-20 production process
AF7	Test and Evaluation of Imaging System	• Eglin AFB has experienced a workload increase at its test facilities due to other industrial partners seeking similar needs

In addition to these findings, it was observed in this study that CRADAs that continue or are extended between organizations is an indicator of progress. What could be more indicative of a successful partnership than wanting to work together again? An example of this finding is illustrated in the CRADA between the Naval Undersea Warfare Center, Division Newport and Precision Signal where now that the work outlined in the agreement has been competed, the partners continue to work together and are in the process of negotiating a follow-on CRADA. Also, even though the CRADA between Ogden Air Logistics Center and Weber State University was originally a two-year agreement, the successful working relationship resulted in extending the CRADA for another year.

Specific Findings

In supporting the belief that successful CRADAs should lead to commercial products, Table 1 depicts those products or product improvements resulting from the sampling of CRADAs evaluated in this study. Some of the products are either still in development or pending commercialization, however, they are at stages where they are considered to be viable products. In some cases, CRADAs provided a means for products to be further refined as a result of the data gathered by the industry partner from the use of DoD facilities or test sites.

In supporting the belief that CRADAs can leverage R&D dollars for both the federal and non-federal partners, Table 2 depicts estimates of the contributions by both partners. The chart clearly shows that by pooling resources through the use of CRADAs, DoD as well as the industry partner can stretch their limited R&D dollars resulting in larger research efforts than either party could fund on their own. These larger, leveraged efforts can result in meeting objectives in a shorter time period than it otherwise would have taken or may even result in meeting the objectives altogether by collaborating with experts in a particular technology area.

The work-in-kind contributed by both the federal and non-federal partners was estimated for 28 out of the 30 CRADAs evaluated in this study. The work-in-kind contributed by the federal participants was estimated to be $4,758,850.00 with that of the non-federal participants estimated to be $5,836,312.00. In extrapolating the figures for work-in-kind contributions for these 28 CRADAs, one can estimate the contributions for the 2456 CRADAs. In doing so, the estimate for work-in-kind for the federal partners is $417,419,128.00 and that for the industry

Table 1. Products Resulting from CRADAs

	CRADA Title	Company	Product	Users	Comments
A3	Construction Equipment Performance Optimization	Caterpillar, Inc. Goodyear Tire and Rubber Co.	• Design tool (currently unnamed) to simulate interaction between tires and deformable surfaces	• Army mobility models, virtual prototyping of vehicles, virtual proving ground concepts	• Product in development • Information on development is highly proprietary
A4	CORE-LOC Concrete Armor Unit	A.R. Wijnberg	• CORE-LOC (previously developed at WES)	• A.R. Wijnberg, an engineering consulting firm, recommended CORE-LOC for application in S. Africa	• Model testing and prototyping of the new armor units by coastal community
A5	Development of Biodegradable Polymers	Zenneca (ICI Americas, Inc.)	• Biodegradable coating for paper • Biopol cup (GSA product)	• Military use	• Cups manufactured by Sweetheart Cup Co. • Navy development effort for compliance with MARPOL Treaty
A8	Formulation of Liposomal Transdermal Vaccine System and Other Novel Pharmaceuticals	MTPPI, Inc.	• Transdermal vaccine delivery system	• Soldiers • Citizens of Third World countries	• In-Vivo studies have been conducted • Product transition phase: Phase I trials for FDA approval
A9	Full Scale Fabrication & Optimization of Composite Cylinder Processing	Composite Development Corporation	• Hockey stick	• Team USA	• Advances in Pultrusion manufacturing techniques
A10	Vaccines for Infectious Diseases	Ora Vax, Inc.	• Vaccine for peptic ulcers • Vaccine for Japanese encephalitis	• Soldiers	• Products in development
N1	CRADA Between the Naval Training Systems Center and the Computer Group of Motorola, Inc.	Motorola, Inc.	• Middleman • Aladdin • Daemon	• DMSTTIAC • DMSO • Joint Theater Missile Defense Command • NAWCAD • Others	• DIS software tools
N2	Deep-Towed Acoustic/Geophysical System	Seafloor Sciences International	• DTAGS	• Navy (geoacoustic properties are important in Anti-Submarine Warfighter operations)	• Refurbished Navy system with upgraded navigation capability
N3	Demonstration of CL-20 Based Explosive Formulations	Thiokol Corporation	• CL-20 (previously developed at NAWC)	• Possible Navy Warhead program • Explosives • Gun propellants	• Demonstration of the high performance of CL-20 for use in warheads
N4	Detection of Contraband Narcotics by Nuclear Quadrupole Resonance/Fast Recovery Time Nuclear Quadrupole Resonance Detection	Quantum Magnetics	• Advanced circuitry to detect narcotics and explosives (previously developed by QM)	• US Customs • Airports • FAA • Embassies	• Incorporated into a larger commercial detection system – Qscann
N7	New Paint Formulations for Fluorinated Polyurethane Resins	21st Century Coatings, Inc.	• WC5: three-coat variant paint system	• AF Fuel storage tanks • Exxon • Navy petroleum tanks • Army Corps of Engineers	• Used to coat inside of petroleum storage tanks • Growing interest in product
N8	Ocean Bottom Profiler (OBP) Joint Project	Precision Signal, Inc.	• 512 Sonar Vehicle	• Universities • Navy	• Mfg. and marketed by Edge Tech, Inc.
N9	Technical Assistance to CIT	Virginia Center for Innovative Technology	• Sea Alert Hat (previously developed by small business)	• Navy • "Around Alone" skippers • Carried in "West Marine" Catalog	• Test site used for testing the radar reflectivity of product
N10	Use of Spinning Microfilters to Separate Oil from Water for Abatement of Marine Oil Spills	Marine Spill Response Corporation	• Spinning microfilter separation process was developed	• Oil companies	• Process was patented
AF1	Automated Software for Composite Material Analysis	AdTech Systems Research, Inc.	• Automated Software for Composite Analysis (ASCA)	• Boeing • Lockheed • United Technologies	• Software for efficient analysis of composite materials
AF2	Covert Adjustable Illuminator CRADA	FLIR Systems, Inc.	• Product for active illumination in near IR to identify ships and aircraft	• Federal and local governments • Marine patrol units	• Commercial product is pending
AF3	Hazardous Materials Management System	Modern Technologies Corporation	• Linden™	• Center for Disease Prevention and Control • Army Redstone Arsenal	• Beta tested a contract-developed software at AFRL
AF4	Helmet Mounted Display Fitness of Use	KOPIN Corporation	• Product assessment of helmet mounted display	• Potential: Military maintenance personnel	• Design was refined
AF5	Ogden Air Logistics Center X-Ray/Computed Tomography Sections	ARACOR	• CT equipment upgrade	• DoE • DLA	• Product improvement
AF6	Strategic Avionics Battle Management Evaluation and Research	Northrop Corporation	• Simulator upgrade	• Services	• Field tests provided data for upgrade to system
AF7	Test and Evaluation of Imaging System	Eastman Kodak Company	• Product assessment of MITE system	• Incorporated into F15	• Design was refined leading to commercial product
AF10	Whole Spacecraft Isolation System for Taurus/GEOSAT	Orbital Sciences Corporation	• Whole Spacecraft Isolation System	• Future satellite systems	• System was built and evaluated

partners is $511,927,938.00. The amount of "cash-in" that the DoD laboratories are receiving from CRADAs is significant and has been increasing over time as shown in Figure 5. These actual dollars that are coming into the laboratories cover such costs as overhead, materials, third party contracts, and travel expenses. The figures for both work-in-kind and cash-in illustrate the importance industry is associating with the CRADA mechanism as well as the significant contribution partnering is making to the DoD mission.

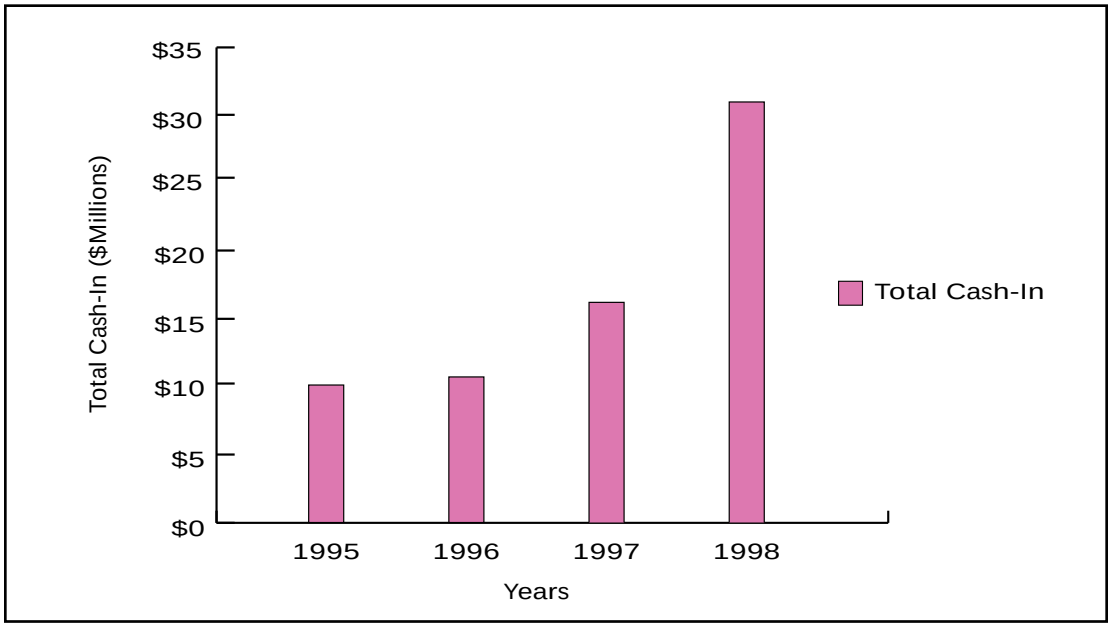

Figure 5. "Cash-In" for DoD CRADAs
(Source: TT Service Managers)

Table 2. Leveraged Efforts via CRADAs

	CRADA Title	DoD Lab	Company	DoD input	Industry Input	Leveraged Effort
A1	Advanced Technology for High Resolution Physics Based Interactive Simulation	U.S. Army CECOM, NVESD	Silicon Graphics, Inc.	1/2 MY ($50K)	1/4 MY ($25K)	$75K
A2	Blanket CRADA Between Ford, General Motors, and Chrysler and the U.S. Tank-Automotive Research, Development, and Engineering Center	U.S. Tank-Automotive Research, Development, and Engineering Center	Ford Motor Company, Chrysler and General Motors	24 MY ($2,400K)	25 MY ($2,500K)	$4,900K
A3	Construction Equipment Performance Optimization	U. S. Army Cold Regions Research and Engineering Laboratory	Caterpillar, Inc. Goodyear Tire and Rubber Co.	5 MY ($500K)	5 MY ($500K)	$1,000K
A4	CORE-LOC Concrete Armor Unit	U.S. Army Engineers' Waterways Experiment Station	A.R. Wijnberg	1/2 MY ($50K)	1/2 MY ($50K)	$100K
A5	Development of Biodegradable Polymers	U.S. Army Natick Research, Development and Engineering Center	Zenneca (ICI Americas, Inc.)	400 hrs ($19.23K)	2000 hrs ($96.15K)	$115.38K
A6	Development of Novel Imaging System for Medical, Non-Destructive Testing and Investigation of Microelectronic Circuits	U.S. Army CECOM, NVESD	Marvin E. Lasser, Inc	100 hrs ($4.8K)	1 MY ($100K)	$104.8K
A7	Evaluation of Electron Cyclotron Resonance Plasma Technology	U.S. Army CECOM, NVESD	Texas Instruments	100 hrs ($4.8K)	1/2 MY ($50K)	$54.8K
A8	Formulation of Liposomal Transdermal Vaccine System and Other Novel Pharmaceuticals	Walter Reed Army Institute of Research	MTPPI, Inc.	N/A	1/2 MY + $250K ($50K + $250K)	N/A
A9	Full Scale Fabrication & Optimization of Composite Cylinder Processing	U.S. Army Research Laboratory	Composite Development Corporation	.3 MY ($30K)	.4 MY ($40K)	$70K
A10	Vaccines for Infectious Diseases	Walter Reed Army Institute of Research	Ora Vax, Inc.	3 MY ($300K)	6 MY + $250K ($600K+$250K)	$1,150K

Table 2. Leveraged Efforts via CRADAs (con't)

	CRADA Title	DoD Lab	Company	DoD input	Industry Input	Leveraged Effort
N1	CRADA Between the Naval Training Systems Center and the Computer Group of Motorola, Inc.	Naval Air Warfare Center, Training Systems Division	Motorola, Inc.	1 MY ($100K)	1 MY ($100K)	$200K
N2	Deep-Towed Acoustic/Geophysical System	Naval Research Laboratory	Seafloor Sciences International	8 months ($66.64K)	7 months + $396K ($58.33K+$396K)	$520.97K
N3	Demonstration of CL-20 Based Explosive Formulations	Naval Air Warfare Center, Weapons Division, China Lake	Thiokol Corporation	1.5 MY ($150K)	1 MY + $40K ($100K+$40K)	$290K
N4	Detection of Contraband Narcotics by Nuclear Quadrupole Resonance/Fast Recovery Time Nuclear Quadrupole	Naval Research Laboratory	Quantum Magnetics	.1 MY ($10K)	6 months ($49.98K)	$59.98K
N5	Electric Vehicle/Hybrid Electric Vehicle Battery Chemistry Research and Evaluation	Naval Surface Warfare Center, Crane Division	AdvanceTek	.25 MY ($25K)	$400K in equipment	N/A
N6	Exploring the Effects of Lipid-Lowering Agents on Complex Cognitive and Performance Tests	Naval Medical Research Institute	Bristol-Meyers Squibb	5 months ($41.65K)	$302K	$343.65K
N7	New Paint Formulations for Fluorinated Polyurethane Resins	Naval Research Laboratory	21st Century Coatings, Inc.	70 days ($27K)	1.25 MY ($125K)	$152K
N8	Ocean Bottom Profiler (OBP) Joint Project	Naval Undersea Warfare Center, Newport Division	Precision Signal, Inc.	3.5 MY ($350K)	3.5 MY ($350K)	$700K
N9	Technical Assistance to CIT	Naval Surface Warfare Center, Dahlgren Division	Virginia Center for Innovative Technology	.04 MY ($4K)	4 hrs ($.192K)	$4.192K
N10	Use of Spinning Microfilters to Separate Oil from Water for Abatement of Marine Oil Spills	Naval Surface Warfare Center, Carderock Division	Marine Spill Response Corporation	1 MY ($100K)	$250K	$350K
AF1	Automated Software for Composite Material Analysis	AFRL/ML	AdTech Systems Research, Inc.	2 MY ($200K)	1.5 MY ($150K)	$350K
AF2	Covert Adjustable Illuminator CRADA	AFRL/DE	FLIR Systems, Inc.	1/2 MY ($50K)	1.25 MY + $10K ($125K+$10K)	$185K
AF3	Hazardous Materials Management System	AFRL/ML	Modern Technologies Corporation	1.5 MY ($150K)	3 MY ($300K)	$450K
AF4	Helmet Mounted Display Fitness of Use	AFRL/HE	KOPIN Corporation	.2 MY ($20K)	1/2 MY + $10K ($50K + $10K))	$80K
AF5	Ogden Air Logistics Center X-Ray/Computed Tomography Sections	Ogden Air Logistics Center	ARACOR	1500 hrs ($72.12K)	175 hrs + $75K ($8.41K+$75K)	$155.53K
AF6	Strategic Avionics Battle Management Evaluation and Research	AFRL/HE	Northrop Corporation	400 hrs ($19.2K)	2.5 MY + $300K ($250K + $300K)	$569.2K
AF7	Test and Evaluation of Imaging System	U.S. Air Force Development Test Center, Eglin AFB	Eastman Kodak Company	1 month ($8.33K)	3 months ($24.99K)	$33.32K
AF8	USAF CRADA Between Weber State University and the Science and Engineering Laboratory	Ogden Air Logistics Center, Technology and Industry Support Directorate	Weber State University	150 hrs ($7.2K)	2900 hrs ($139.42K)	$146.62K
AF9	Warhead Arena Test	U.S. Air Force Development Test Center, Eglin AFB	Hughes Missile Systems	550 hrs ($26.44K)	2 weeks + $58K ($3.84K + $58K)	$88.28K
AF10	Whole Spacecraft Isolation System for Taurus/GEOSAT	AFRL/VS	Orbital Sciences Corporation	30 hrs ($1.44K)	.3 MY ($30K)	$31.44K

Assume: 1MY = $100K N/A: not available MY: Man-year * Actual cash-in is shown as dollar values next to the estimates for man-years of effort